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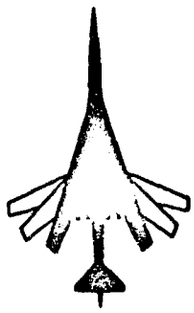

PROPULSION SYSTEM PERFORMANCE SPECIFICATION

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PRATT & WHITNEY AIRCRAFT JTF 17A-20B ENGINE INSTALLATION

COMMERCIAL
SUPERSONIC TRANSPORT
PROGRAM

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PHASE II-C
INTERIM AIRCRAFT PERFORMANCE
ASSESSMENT REPORT

NOVEMBER 15, 1965
CONTRACT -FA-SS-66-5

THE BOEING COMPANY
RENTON, WASHINGTON, U.S.A.

ISSUE No. 8

D6-19906-2

CONTENTS

ILLUSTRATIONS

ILLUSTRATIONS (Cont.)

1.0 SCOPE

This specification defines the installed performance of the 650-pound-per-second Pratt & Whitney JTF17A-20B engine in the Boeing Model 733-394 airplane. Performance data are presented for the initial service (1900°F) engine and the basic (2200°F) engine. The estimated inlet drag values used for the determination of airplane performance characteristics are also specified.

System performance requirements established herein are design objectives to be applied to the prototype airplanes. Application of these requirements to production airplane design will be established after prototype flight testing.

2.0 APPLICABLE DOCUMENTS

The following documents are to be used in conjunction with this specification:

	Pratt & Whitney Specification 2681 - Engine Model JTF17A-20B, October 30, 1964, Revised November 1, 1965
	Pratt & Whitney Engine Performance Data Decks 5173 Low TIT and 5172 High TIT, September 15, 1965

The documents listed below are Boeing publications:

D6-19907	Power Plant Installation Performance Specification
D6-19909	Air Induction System Performance Specification
D6-19905	Air Induction System Performance Specification
D6-19908	Propulsion Control System Performance Specification.

3.0 PROPULSION SYSTEM DESCRIPTION

3.1 ENGINE

The P&WA JTF17A-20B engine is a twin-spool, axial-flow, turbofan engine incorporating a full-length fan duct with duct heater, a variable-geometry nozzle for the fan duct, a blow-in-door, convergent-divergent ejector nozzle, and a thrust reverser. A detailed engine description with special features required for installation is contained in the Pratt & Whitney Model Specification. The airplane engine installation is described in Boeing Document D6-19907, Power Plant Installation Performance Specification.

3.2 PROPULSION POD

The propulsion pod incorporates a variable centerbody air induction system, an unpressurized nacelle, remotely mounted aircraft accessories, and an exhaust nozzle system with thrust reverser. The air induction system is described in Boeing Document D6-19909, Air Induction System Performance Specification.

3.3 CONTROL

Installed performance is based on air induction control system and engine control system described in Boeing Documents D6-19905, Air Induction Control System Performance Specification and D6-19908, Propulsion Control System Performance Specification, respectively.

4.0 INSTALLED ENGINE PERFORMANCE

4.1 CALCULATION PROCEDURE

The installed engine performance is calculated by the use of Pratt & Whitney Performance Data Deck (see Section 2.0). The data deck is capable of accurate calculation of engine performance, including the installed effects of inlet recover, nozzle coefficient, and bleed and power extraction, within engine limits. For the performance calculations the low airflow schedule was used.

a. Performance Assumptions

The engine performance determination was made under the following assumptions:

- Atmosphere: Performance is based on U.S. Standard Atmosphere, 1962 - Geometric Altitude.
- Fuel: Performance is based on fuel specification ASTM D1655 Jet A or A-1 Type Aviation kerosene, conforming to Pratt & Whitney Fuel Specification PWA 533, with a lower heating value of 18,500 Btu per pound.

b. Inlet Total Pressure Recovery

The inlet total pressure recovery used to calculate installed engine performance is shown in Fig. 1.

c. Nozzle Coefficient

The nozzle thrust coefficient used to calculate installed engine performance is shown in Fig. 2. External boattail drag is included in this thrust coefficient. The nozzle thrust coefficients are based on a secondary corrected cooling flow $\left(\frac{W_s}{W_p}\sqrt{\frac{T_s}{T_p}}\right)$ equal to 3 percent for duct-heater temperatures above 2750°R and a secondary corrected cooling flow of 2 percent for duct heater temperatures below 2750°R. The ram drag of the secondary air is included in the thrust coefficients shown on Fig. 2.

d. Horsepower Extraction

Table A lists the horsepower extracted from the engine for various flight conditions to supply power for aircraft systems.

e. Engine Airbleed

Table A lists the airbleed extracted from the high-pressure compressor for various flight conditions to supply high-pressure air for aircraft systems.

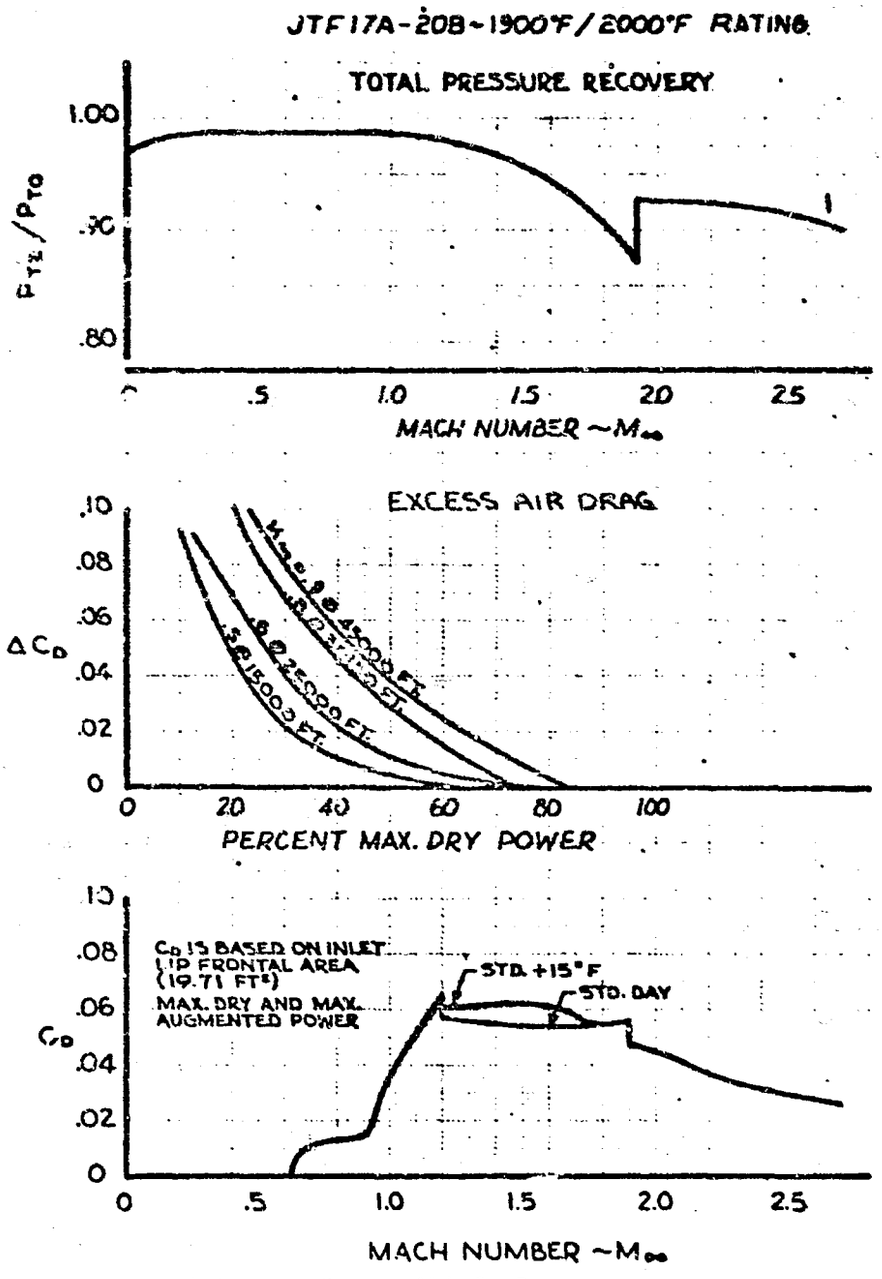

Fig. 1 Installed Inlet Drag Coefficients and Inlet Ram Recovery

JTF17A-20B ~ 1900°F / 2000°F RATING

$$C_{EPMR} = \frac{\text{EJECTOR GROSS THRUST} - \left(\begin{array}{l}\text{EXTERNAL PRESSURE DRAG} + \\ \text{FULL SECONDARY RAM DRAG}\end{array}\right)}{\text{IDEAL GROSS THRUST OF ENGINE AND FAN STREAMS}}$$

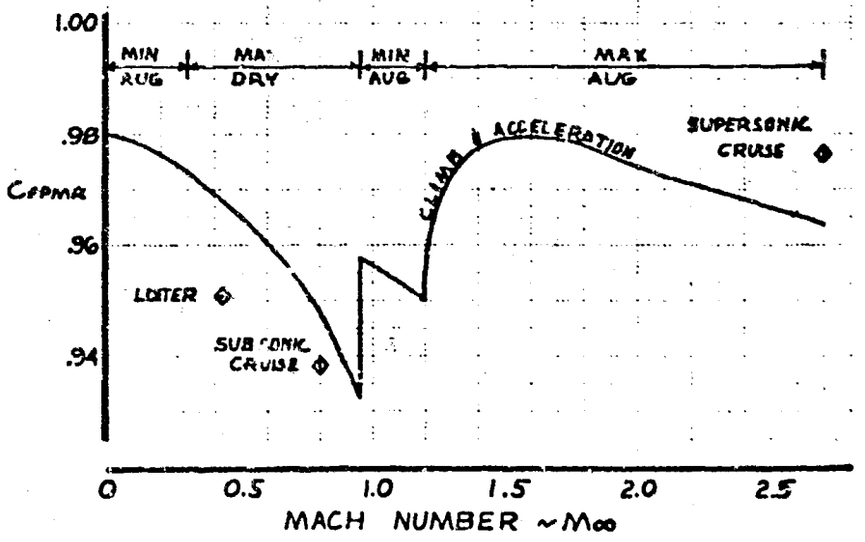

Fig. 2 Thrust Coefficient

Table A Horsepower and Bleed Air Extractions

Airplane Operating Condition	Horsepower Extraction per Engine	Bleed Air (pounds per second per engine) Compressor	Inlet
Takeoff	325	--	1.6
Climb and Acceleration	350	--	1.6
Supersonic Cruise	300	--	1.3
Holding at Mach 0.4, 15,000 feet	300	--	2.8
Cruise to Alternate at Mach 0.8, 36,150 feet	300	--	2.8
Descent	250	1.4	1.2

f. Engine Operating Envelope

The standard-day operating envelope for the engine is shown in Fig. 3.

4.2 ENGINE PERFORMANCE CURVES (1900°F)

Installed-engine performance curves for the initial service (1900°F) engine for standard and nonstandard day are shown on Figs. 4 through 16.

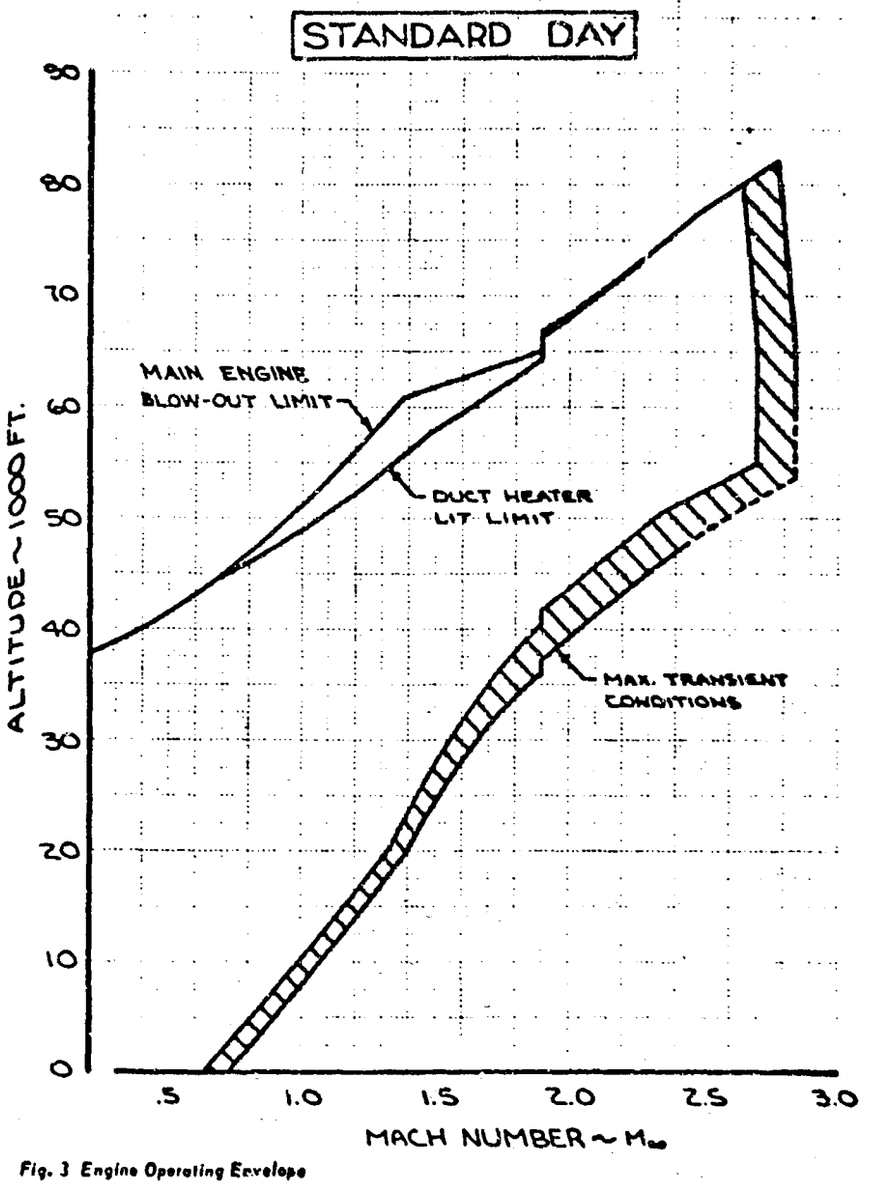

Fig. 3 Engine Operating Envelope

JTF 17A-20B ~ 1900°F/2000°F RATING

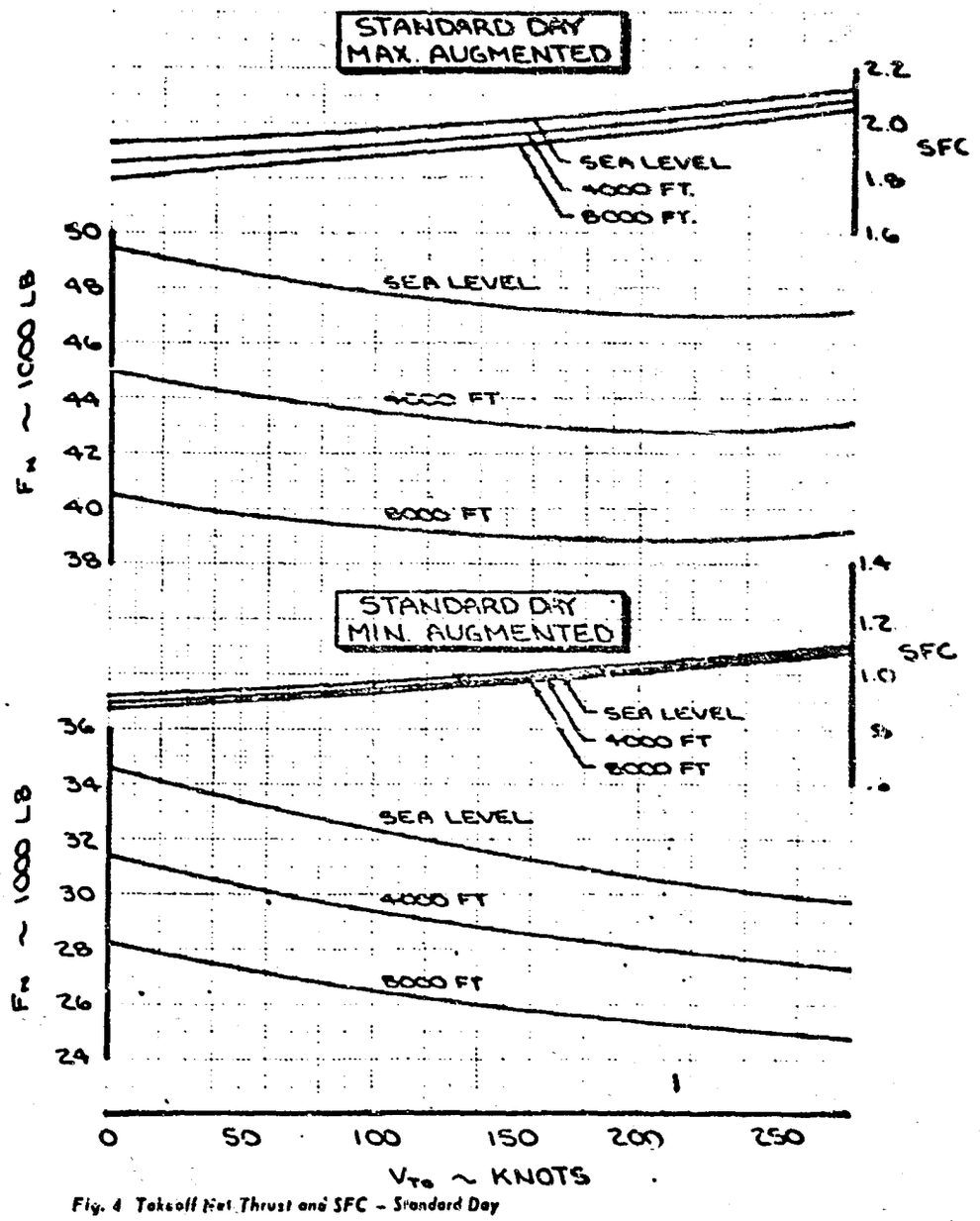

Fig. 4 Takeoff Net Thrust and SFC – Standard Day

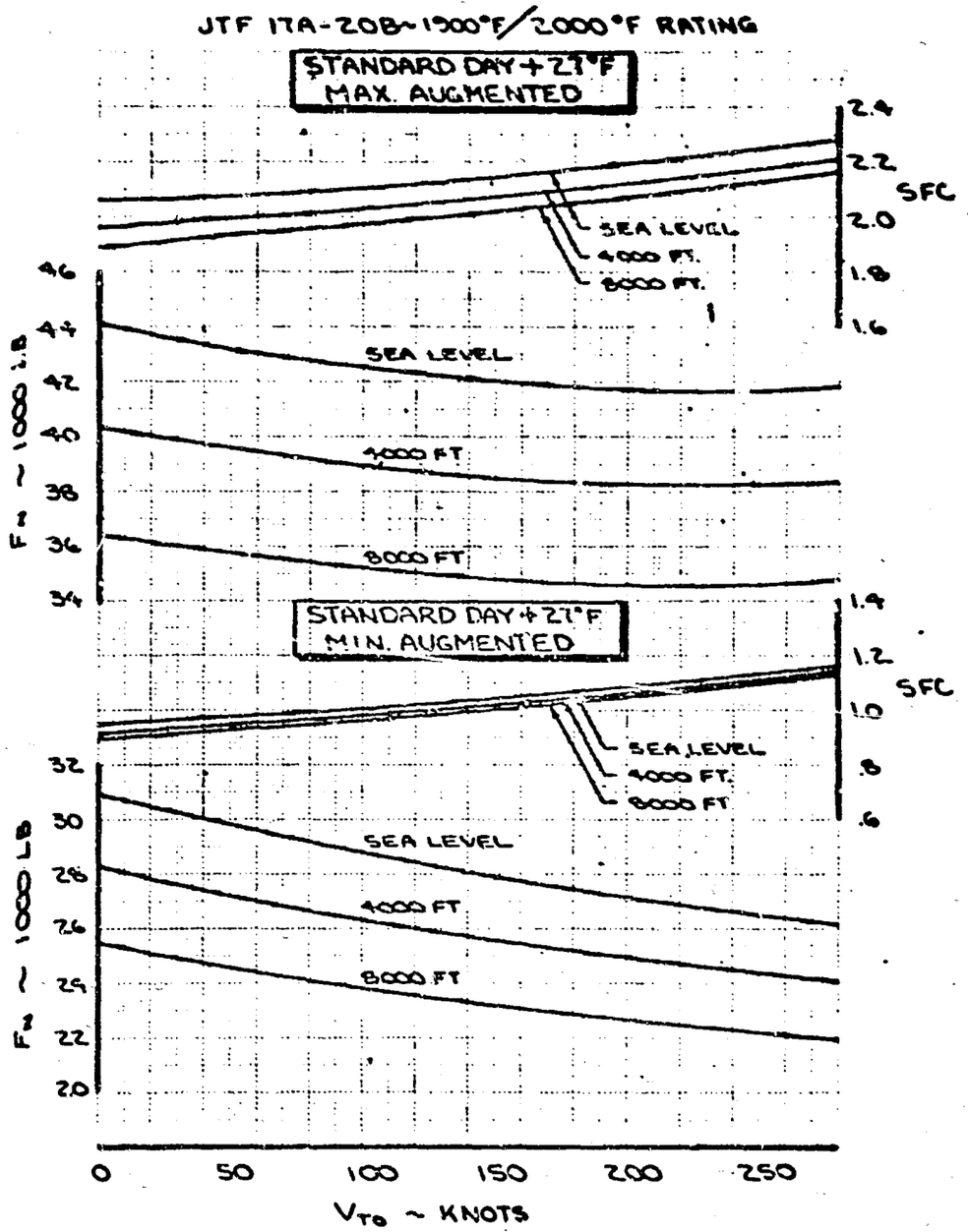

Fig. 5 Takeoff Net Thrust and SFC – Standard Day + 27°F

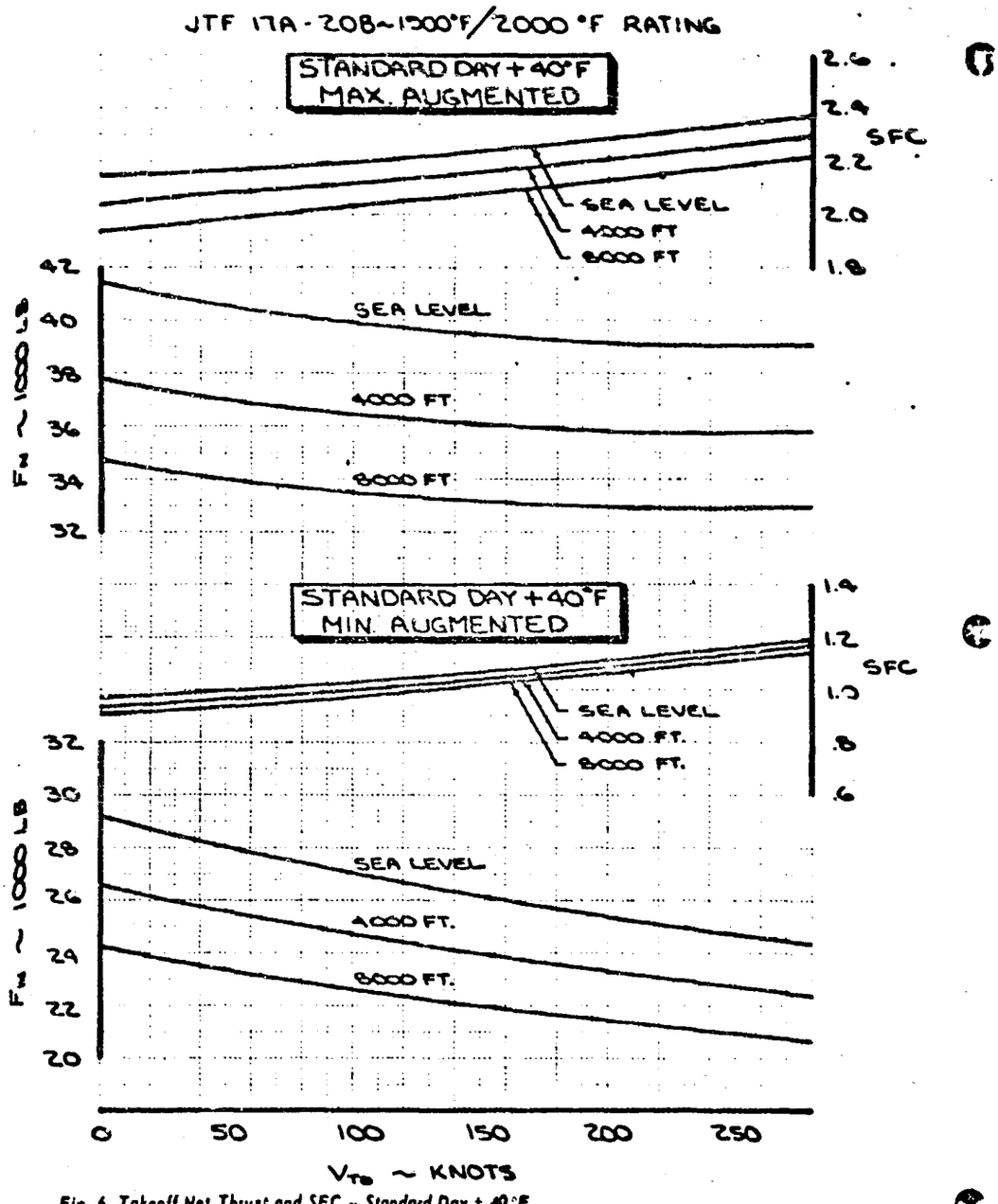

Fig. 6 Takeoff Net Thrust and SFC ~ Standard Day + 40°F

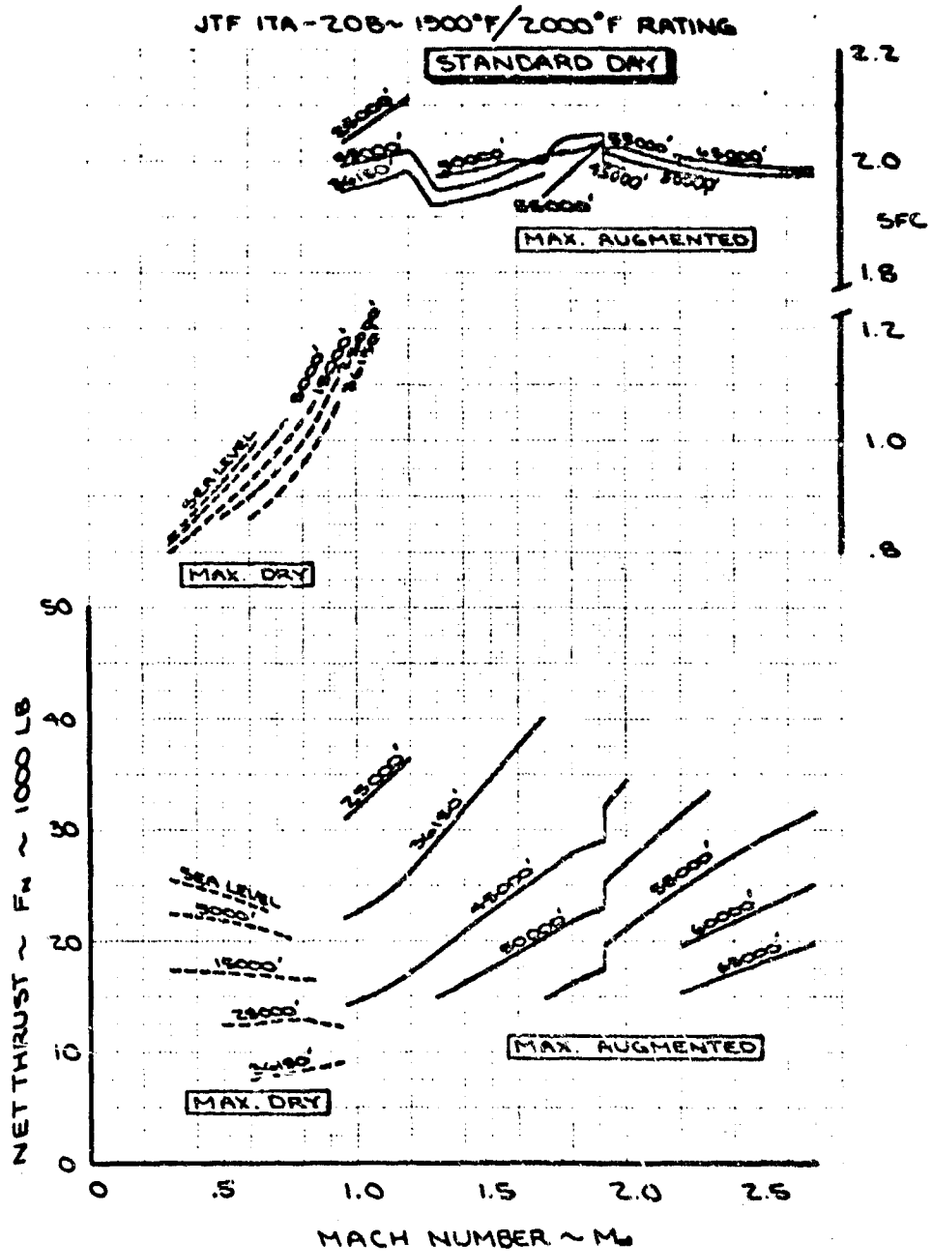

Fig. 7 Climb and Acceleration Net Thrust and SFC – Standard Day

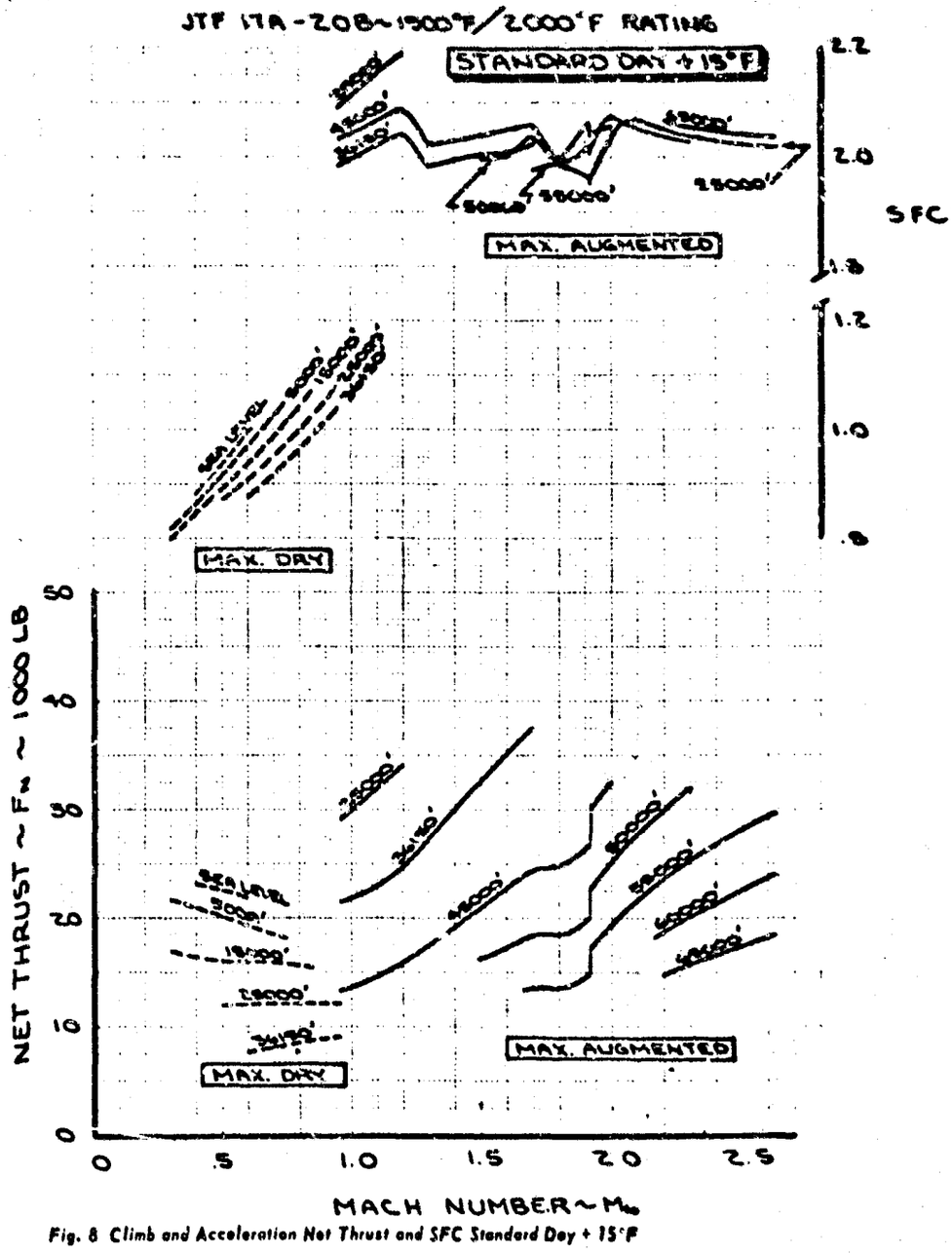

Fig. 8 Climb and Acceleration Net Thrust and SFC Standard Day + 15°F

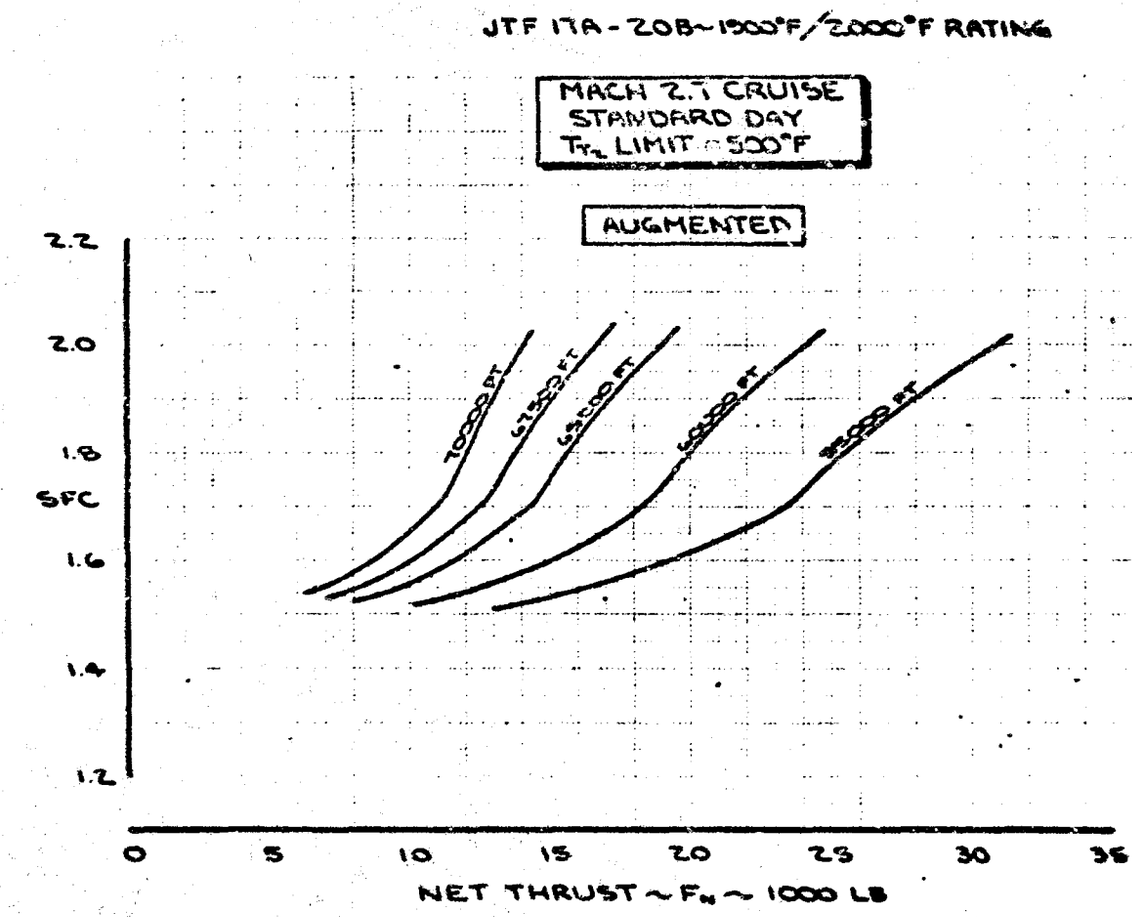

Fig. 9 Cruise Net Thrust and SFC – Standard Day

CONFIDENTIAL

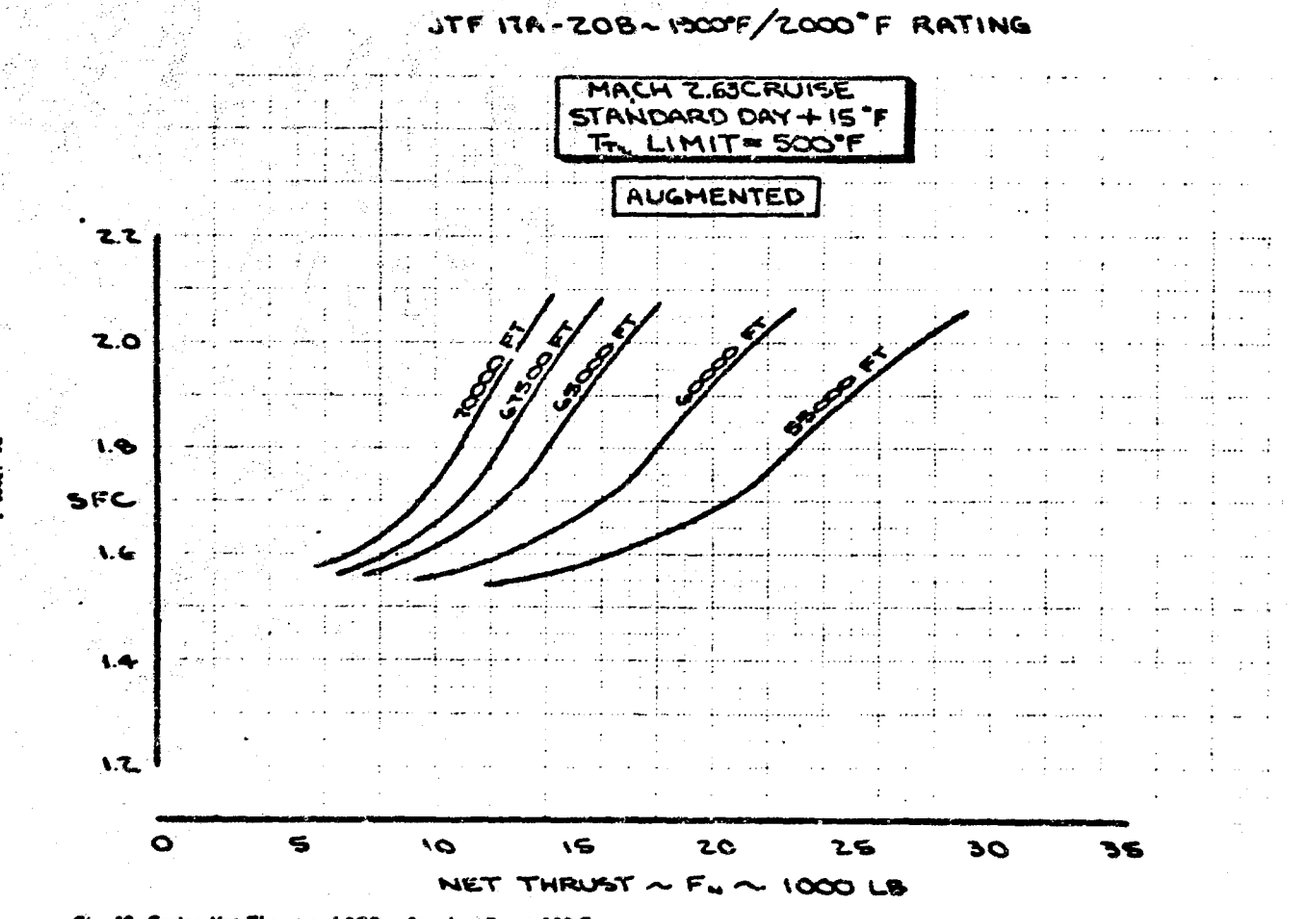

Fig. 10 Cruise Net Thrust and SFC – Standard Day + 15° F

JTF 17A-20B~ 1900°F/2000°F RATING

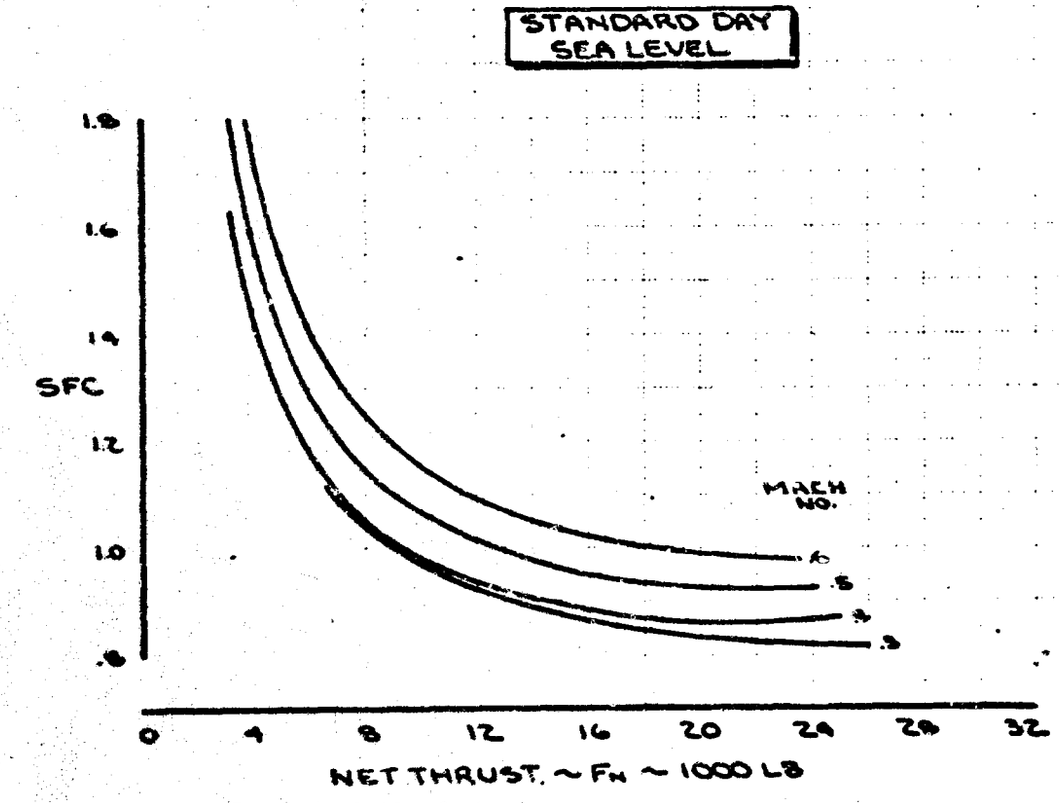

Fig. 11 SFC versus Thrust – Standard Day, Sea Level

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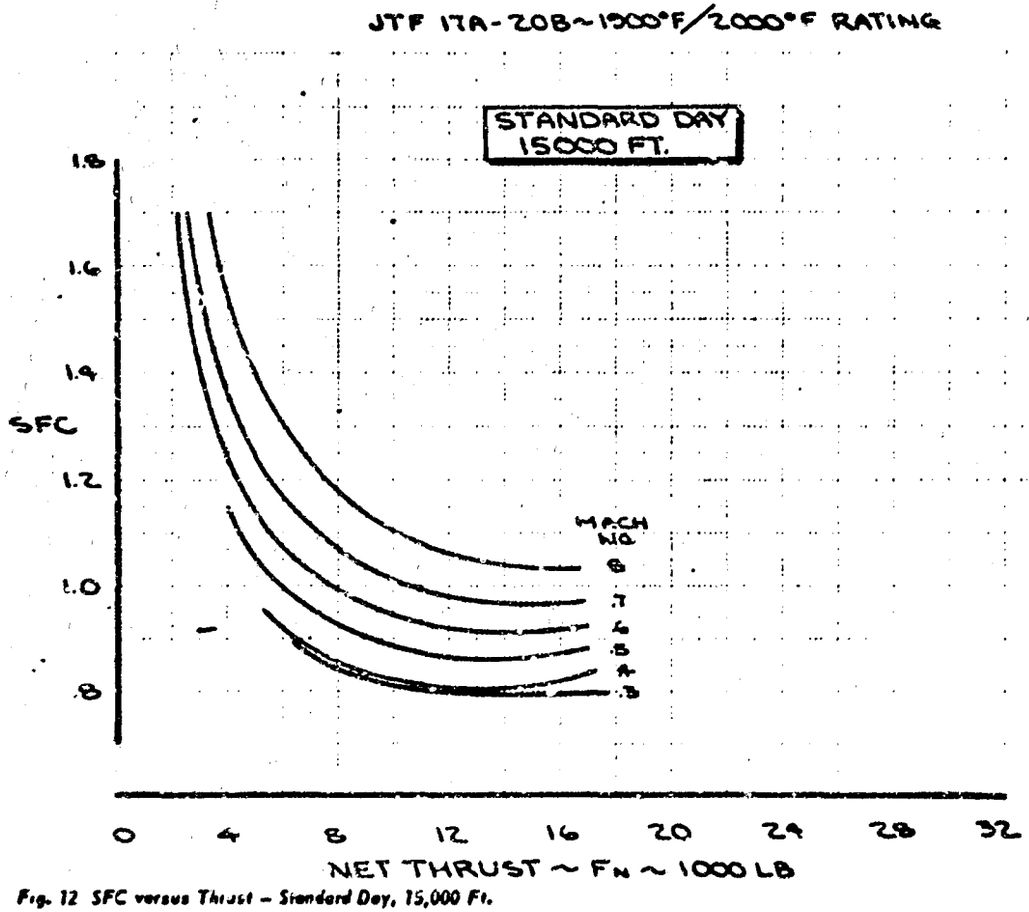

Fig. 12 SFC versus Thrust – Standard Day, 15,000 Ft.

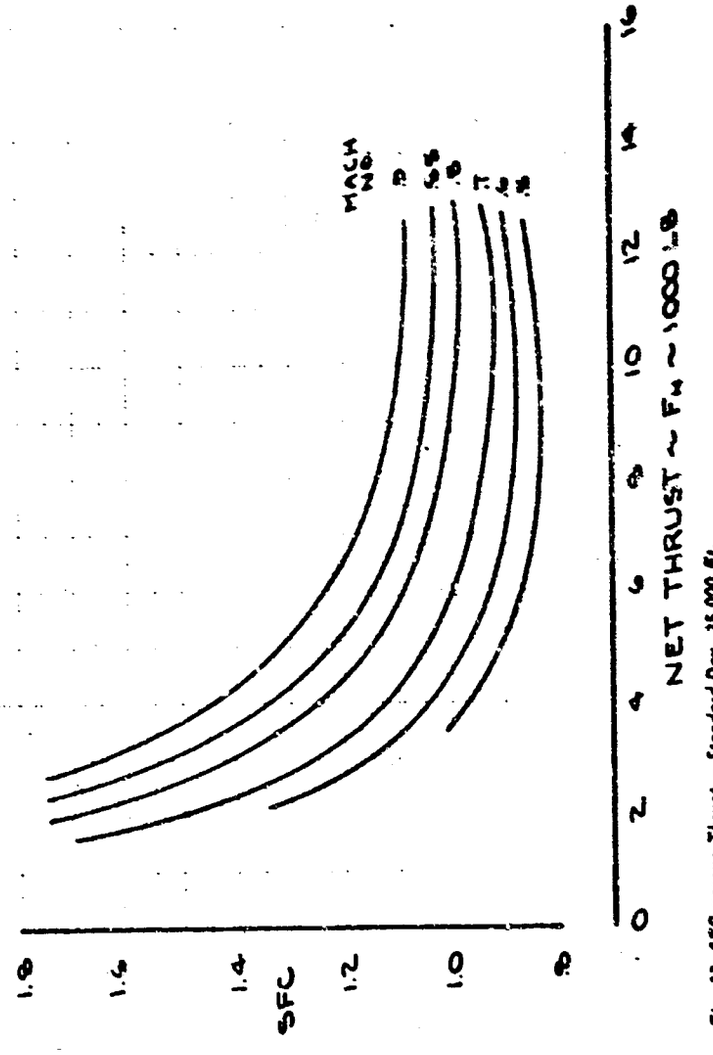

Fig. 13 SFC versus Thrust - Standard Day, 25,000 Ft.

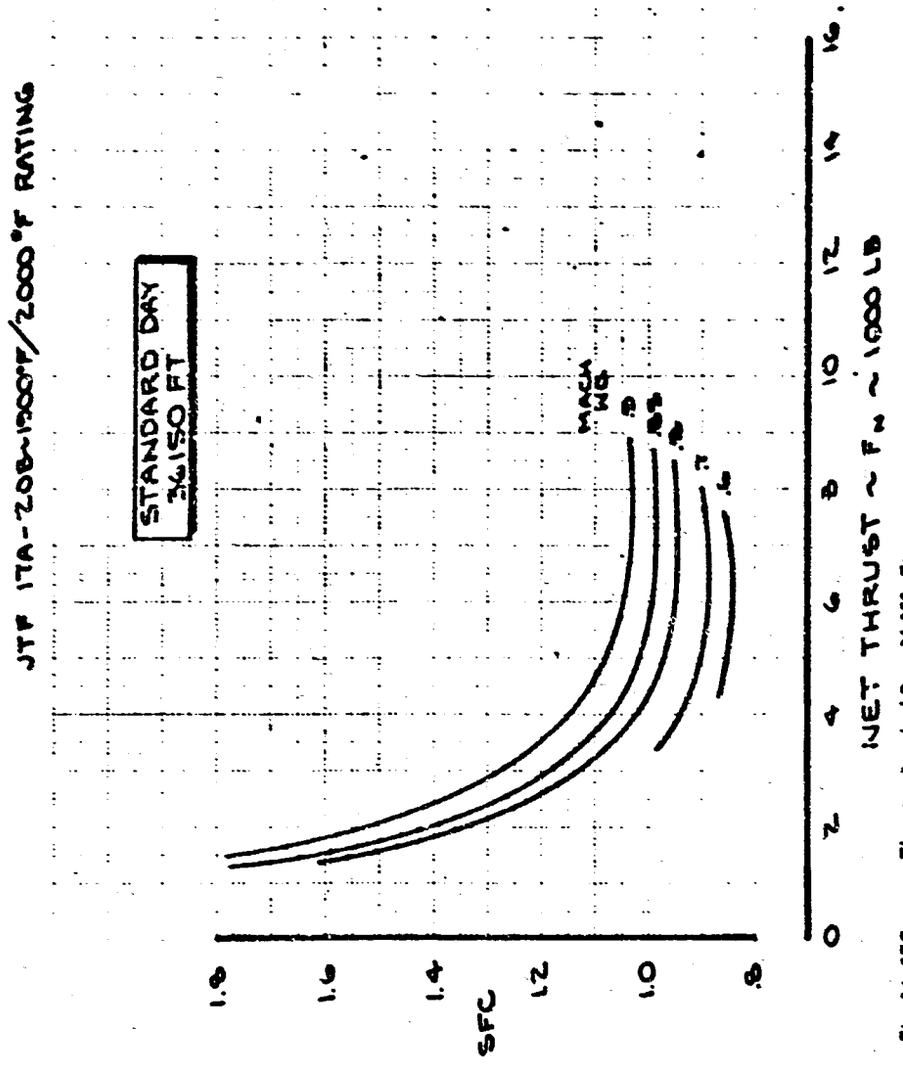

Fig. 14 SFC versus Thrust – Standard Day, 36,150 Ft.

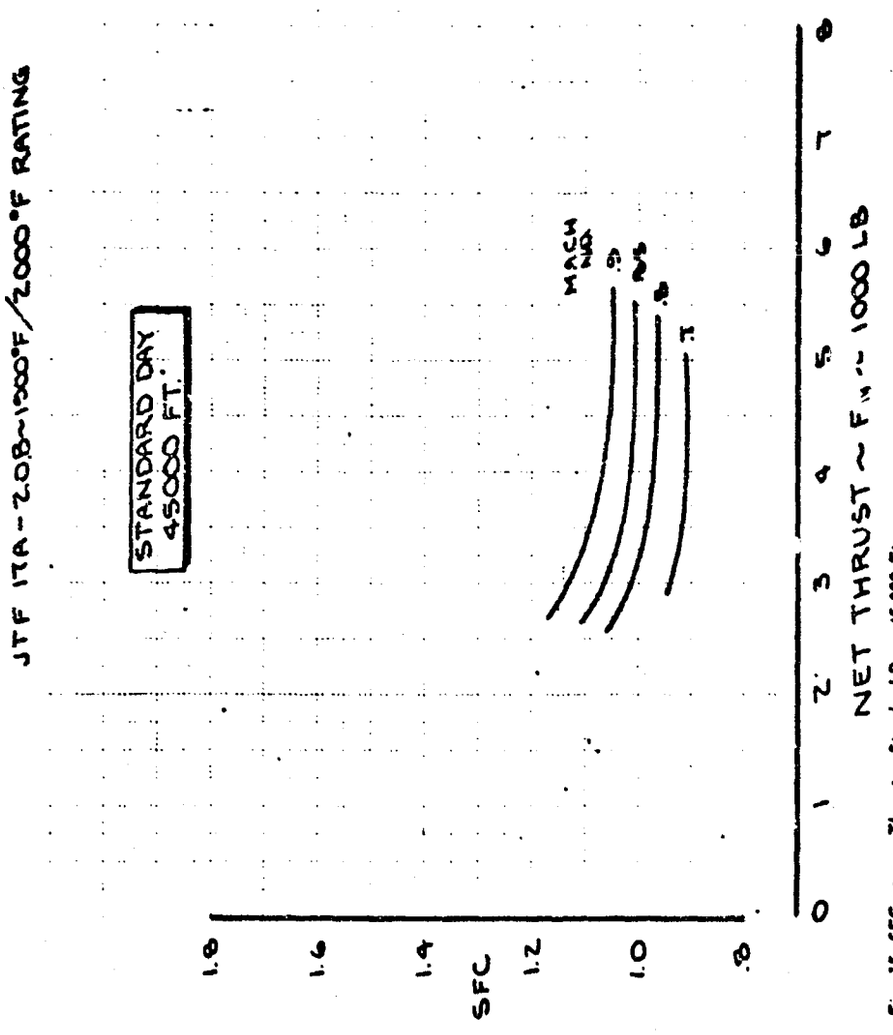

Fig. 15 SFC versus Thrust – Standard Day, 45,000 Ft.

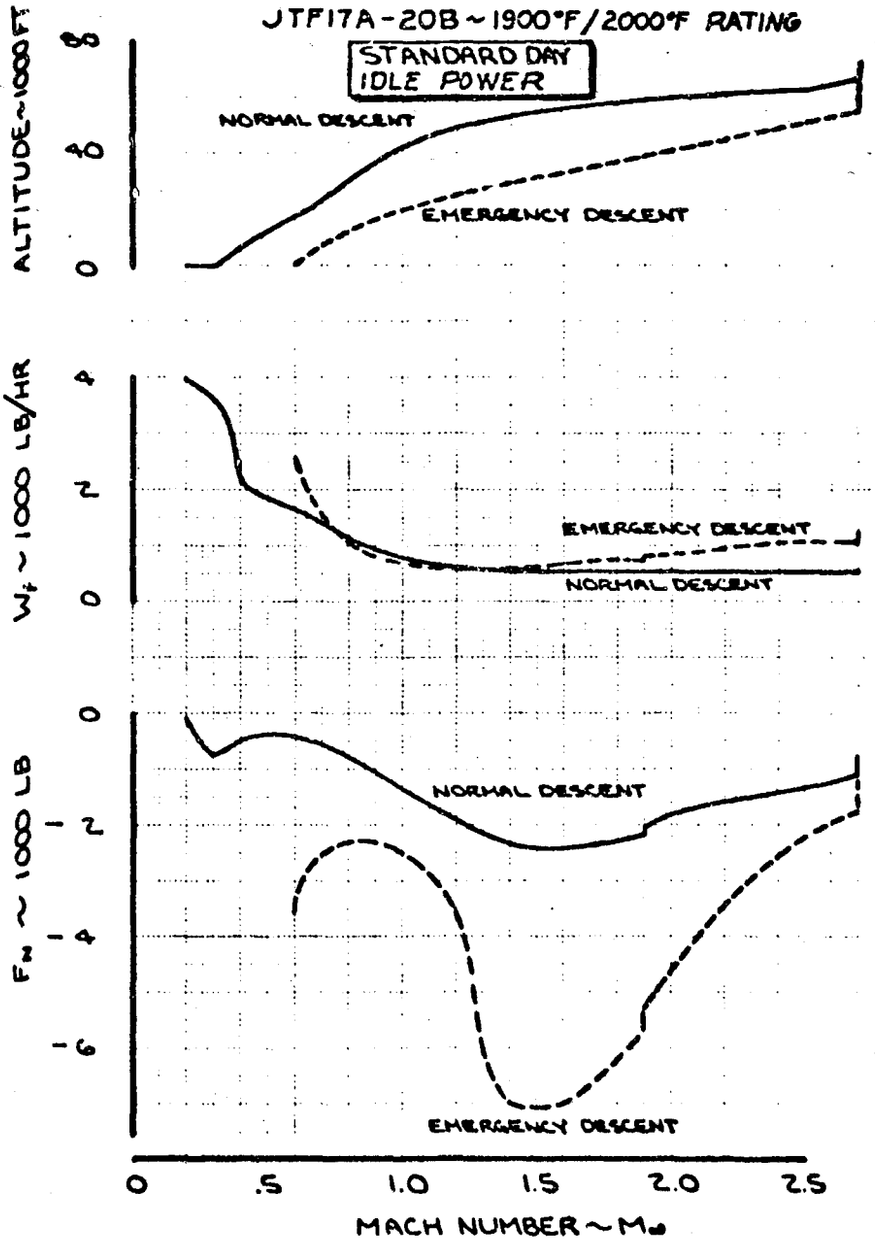

Fig. 16 Normal and Emergency Descent – Thrust and Fuel Flow – Standard Day

5.0 PROPULSION SYSTEM DRAG

5.1 INLET DRAG

Inlet drag is included in the airplane drag build-up for airplane performance calculations. The inlet drag includes spillage, cowl suction, bypass momentum, bypass louver, boundary layer bleed, and aircraft air-conditioning bleed drags. Table A lists the airbleed extracted from the inlet for various flight conditions to supply high-pressure air for air conditioning.

Fig. 1 shows the inlet drag for maximum dry and augmented power settings during standard and hot-day operation. The excess air drag at partial power when engine airflow demand is reduced is also shown on Fig. 1.

The inlet drag during normal and emergency descent operation at idle power settings is shown in Fig. 17.

5.2 NOZZLE DRAG

No correction to airplane drag is made for nozzle external drag because this drag is included in the nozzle thrust coefficient.

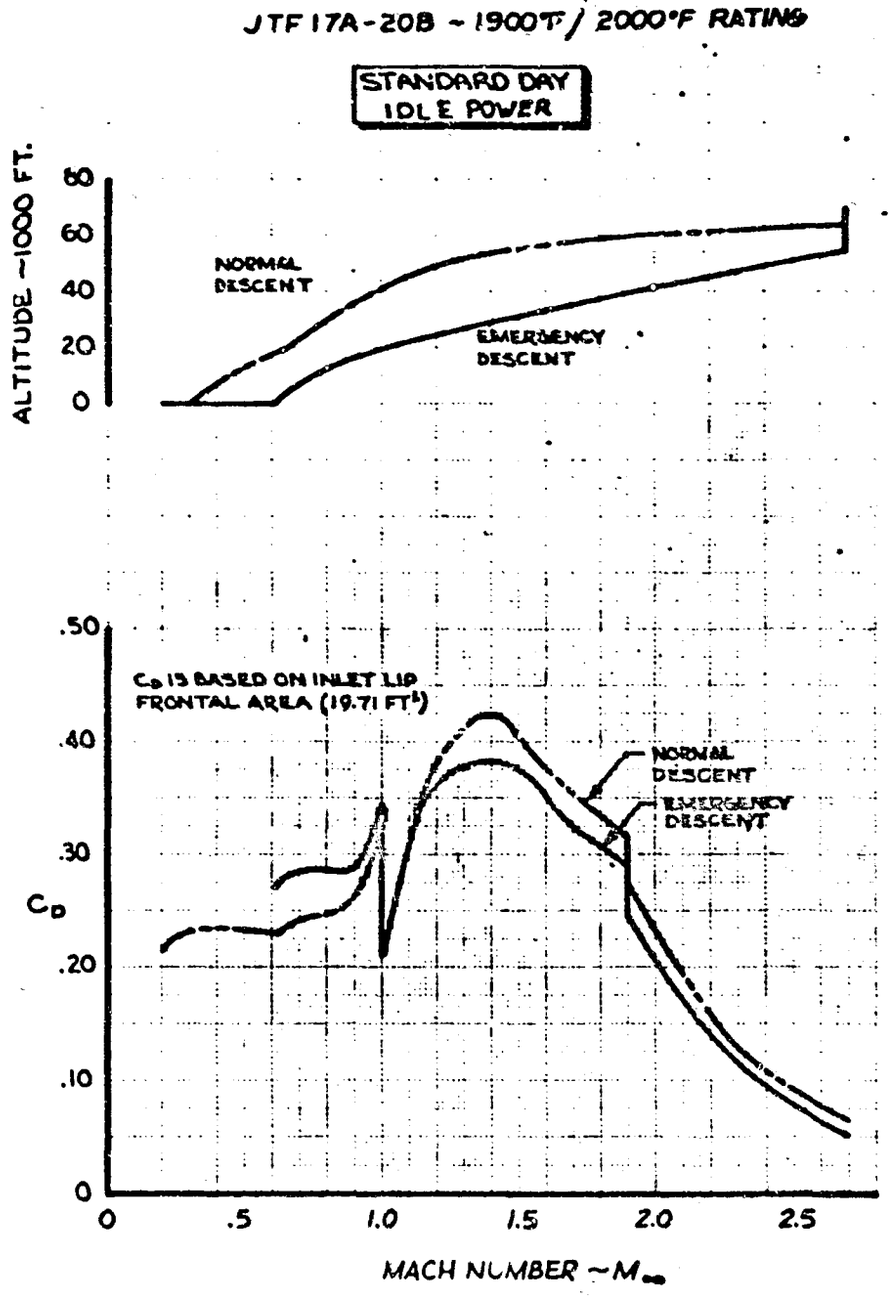

Fig. 17 Installed Inlet Drag Coefficients – Idle Descent

D6-19906-2

APPENDIX

JTF17A-20B 2200°F/2300°F

The appendix (Figs. A-1 through A-12) presents the installed engine performance data for the "basic" PWA JTF17A-20B turbofan engine rated at 2200°F cruise turbine-in-temperature.

The airflow schedule and inlet drags for this engine are the same as for the 1900°F engine.

JTF 17A-20B ~2200°F/2300°F RATING

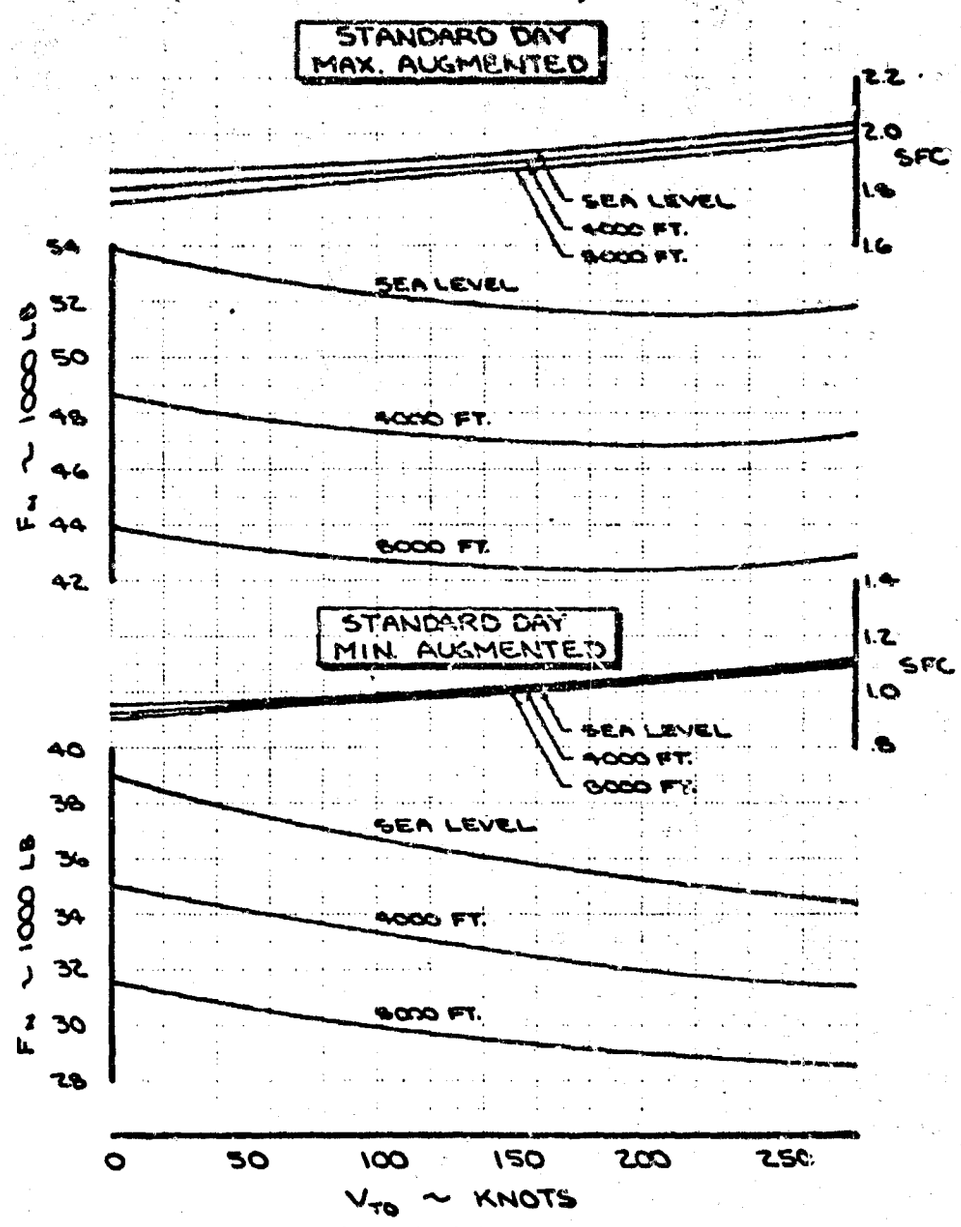

Fig. A-1 Takeoff Net Thrust and SFC – Standard Day

JTF 17A-208 ~ 2200°F/2300°F RATING

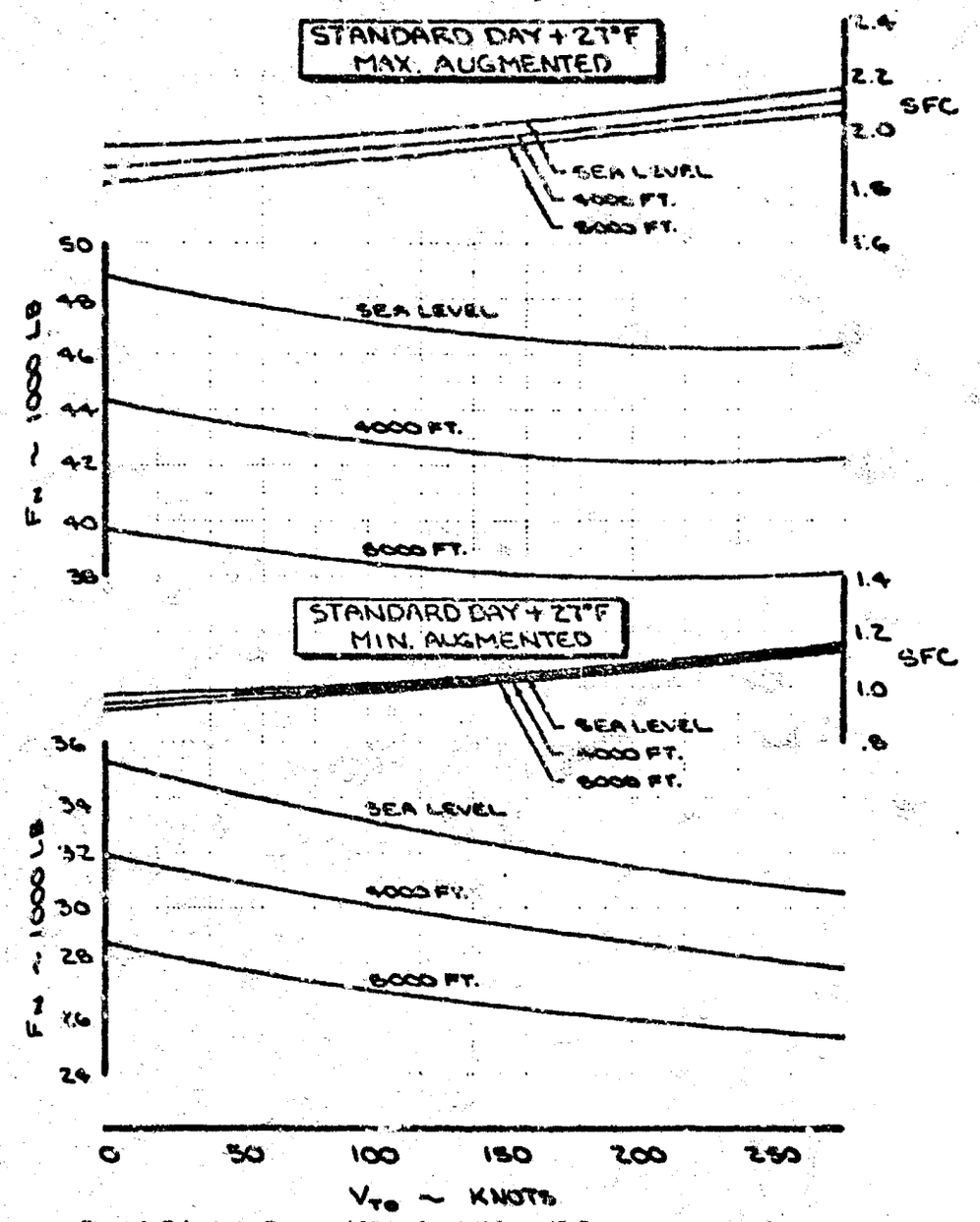

Fig. A-2 Takeoff Net Thrust and SFC – Standard Day + 27°F

JTF 17A-20B ~2200°F/2300°F RATING

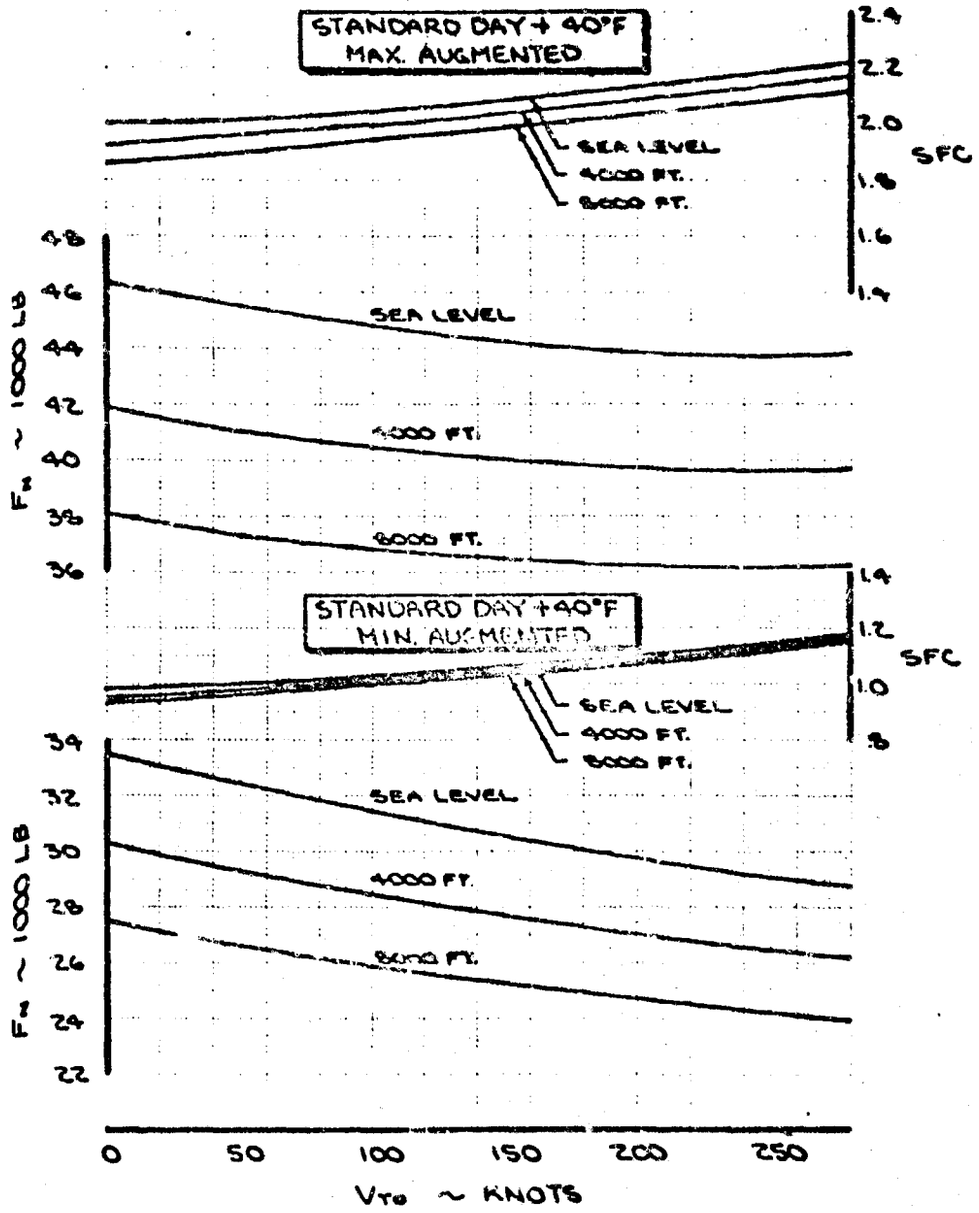

Fig. A-3 Takeoff Net Thrust and SFC – Standard Day + 40°F

JTF 17A-27B - 2200°F/2900°F RATING

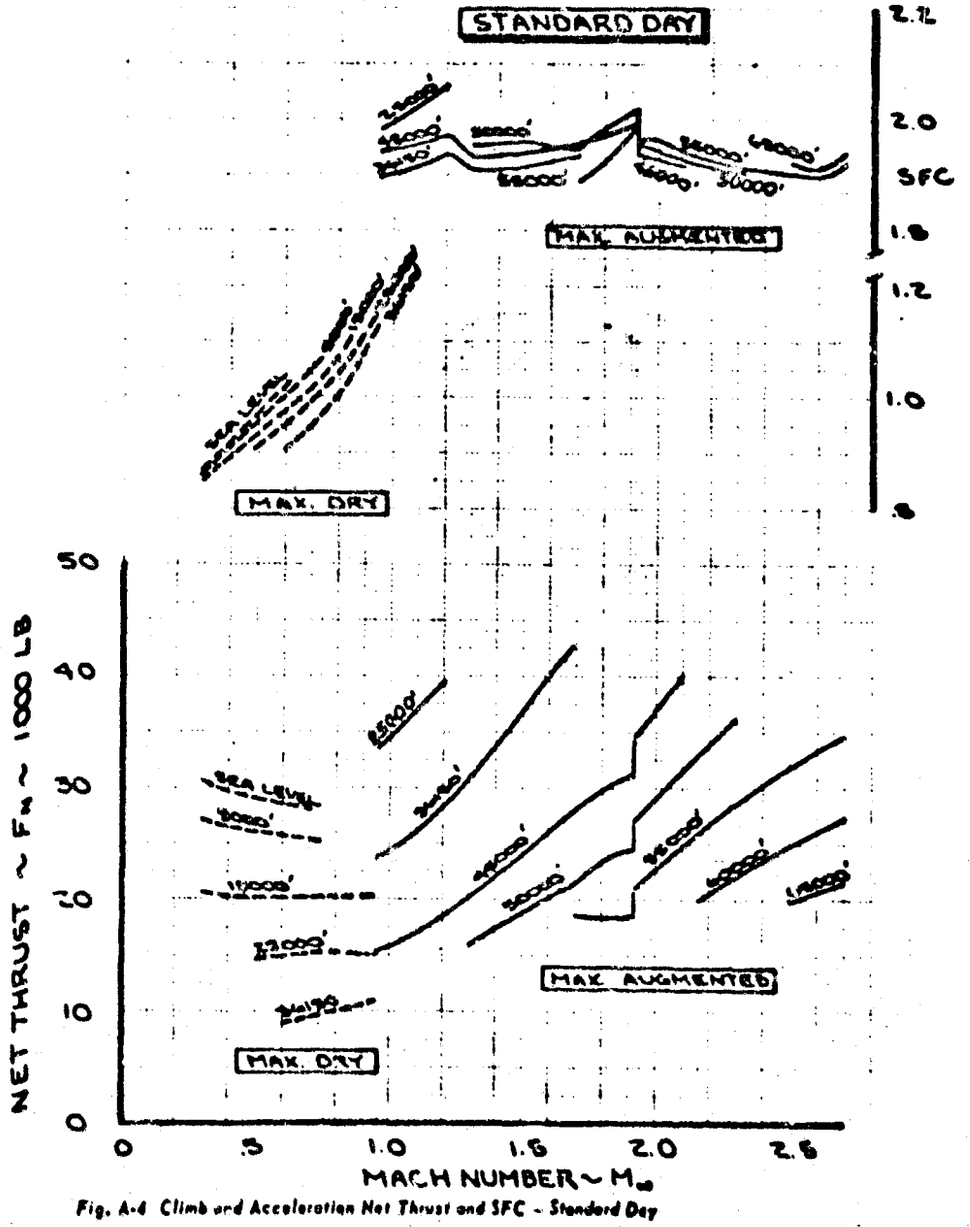

Fig. A-4 Climb and Acceleration Net Thrust and SFC - Standard Day

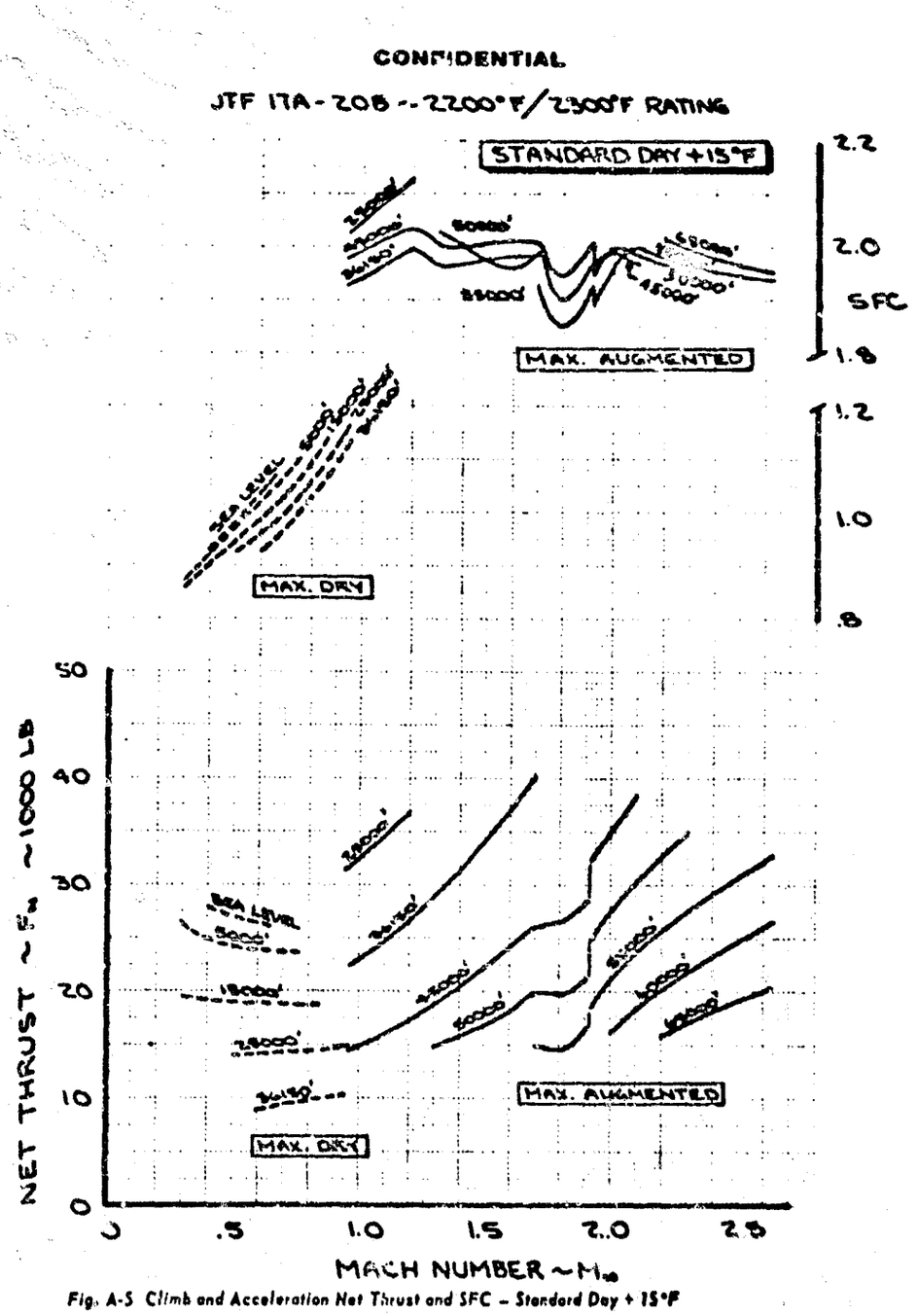

Fig. A-5 Climb and Acceleration Net Thrust and SFC – Standard Day + 15°F

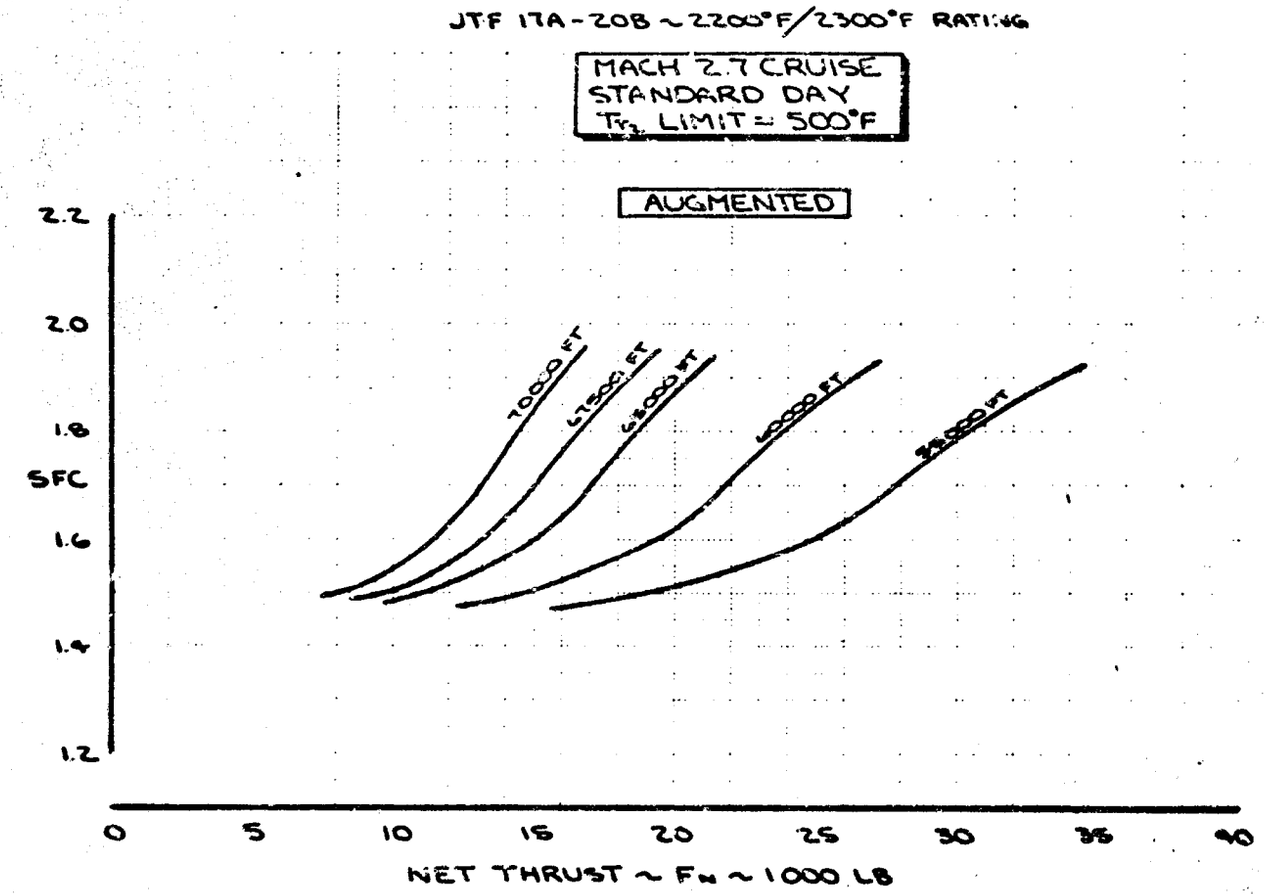

Fig. A-6 Cruise Net Thrust and SFC – Standard Day

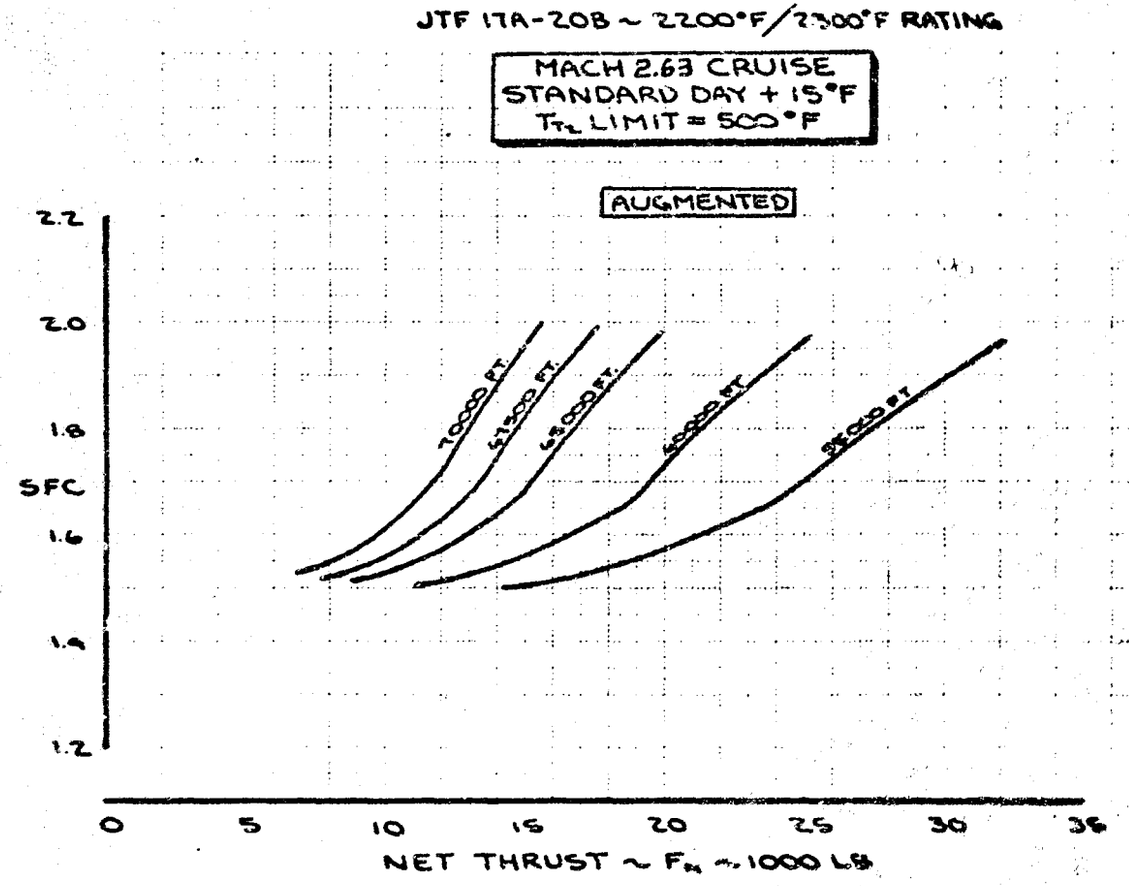

Fig. A-7 Cruise Net Thrust and SFC – Standard Day + 15°F

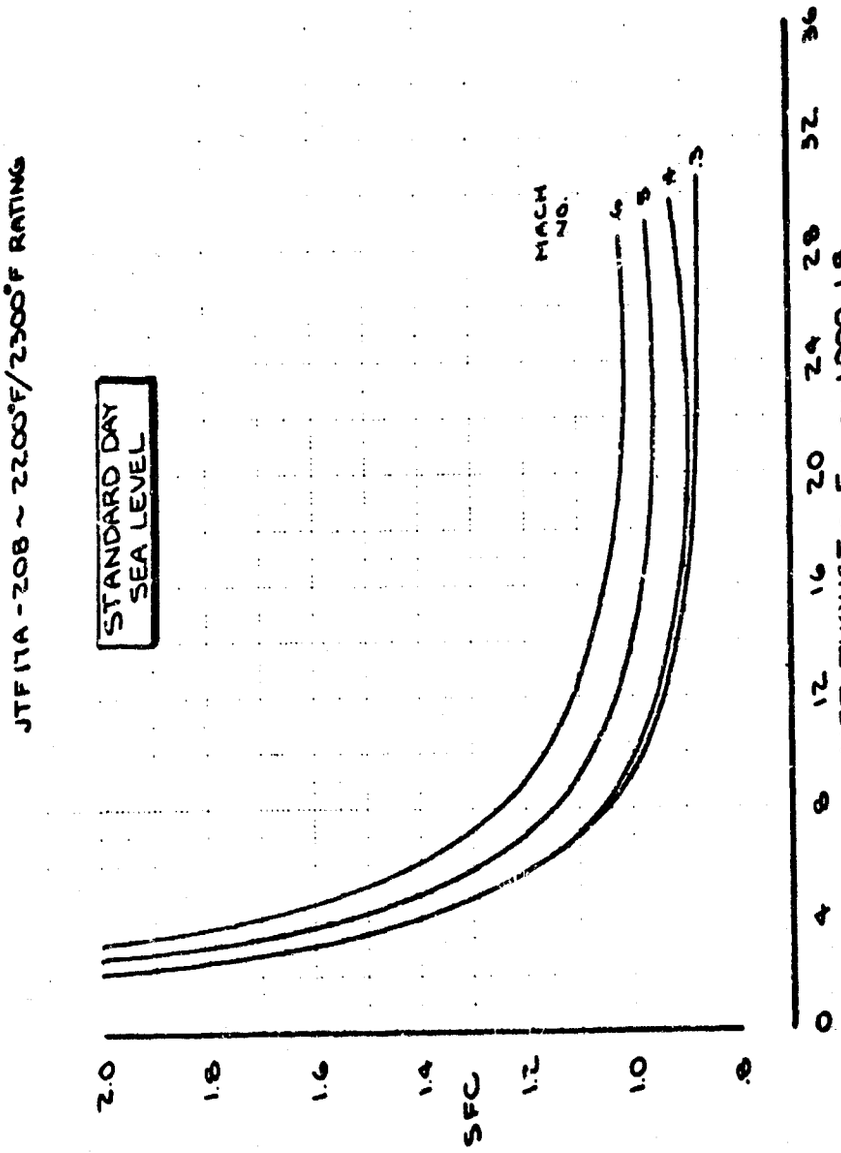

Fig. 4-4 SFC versus Thrust Standard Day, Sea Level

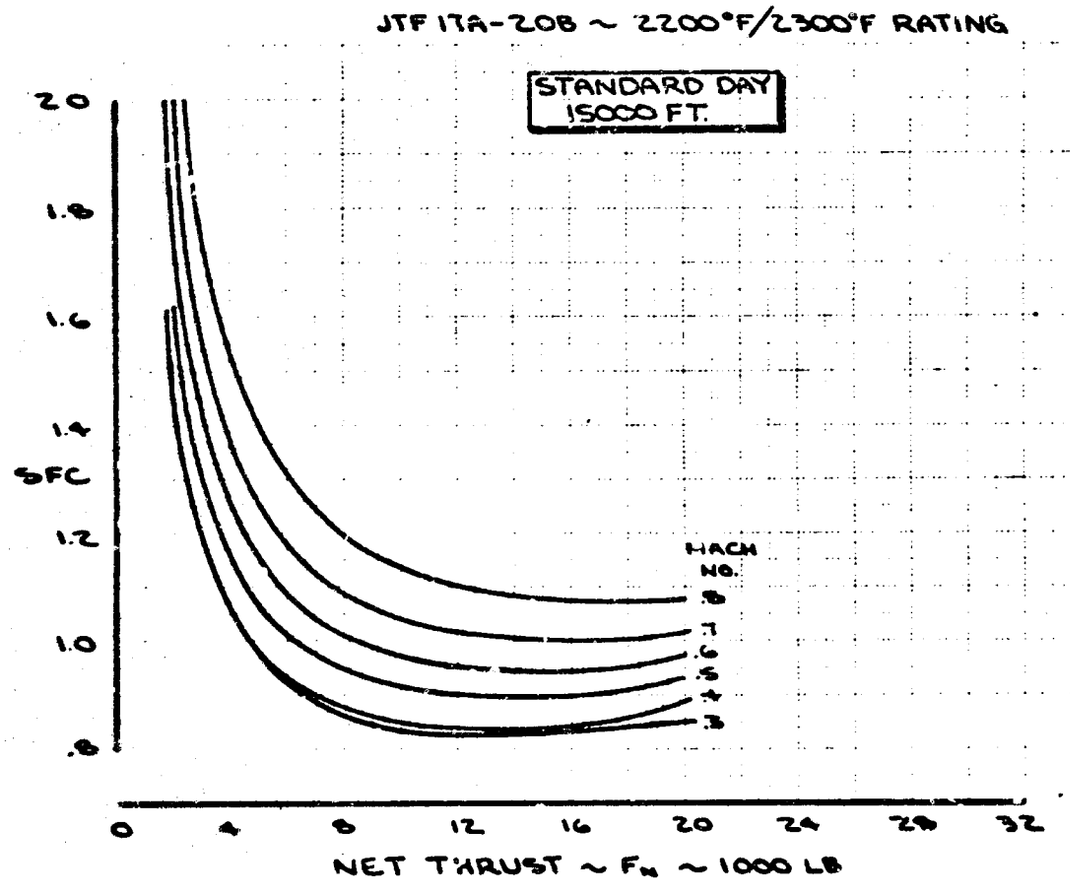

Fig. A-9 SFC versus Thrust Standard Day, 15,000 ft.

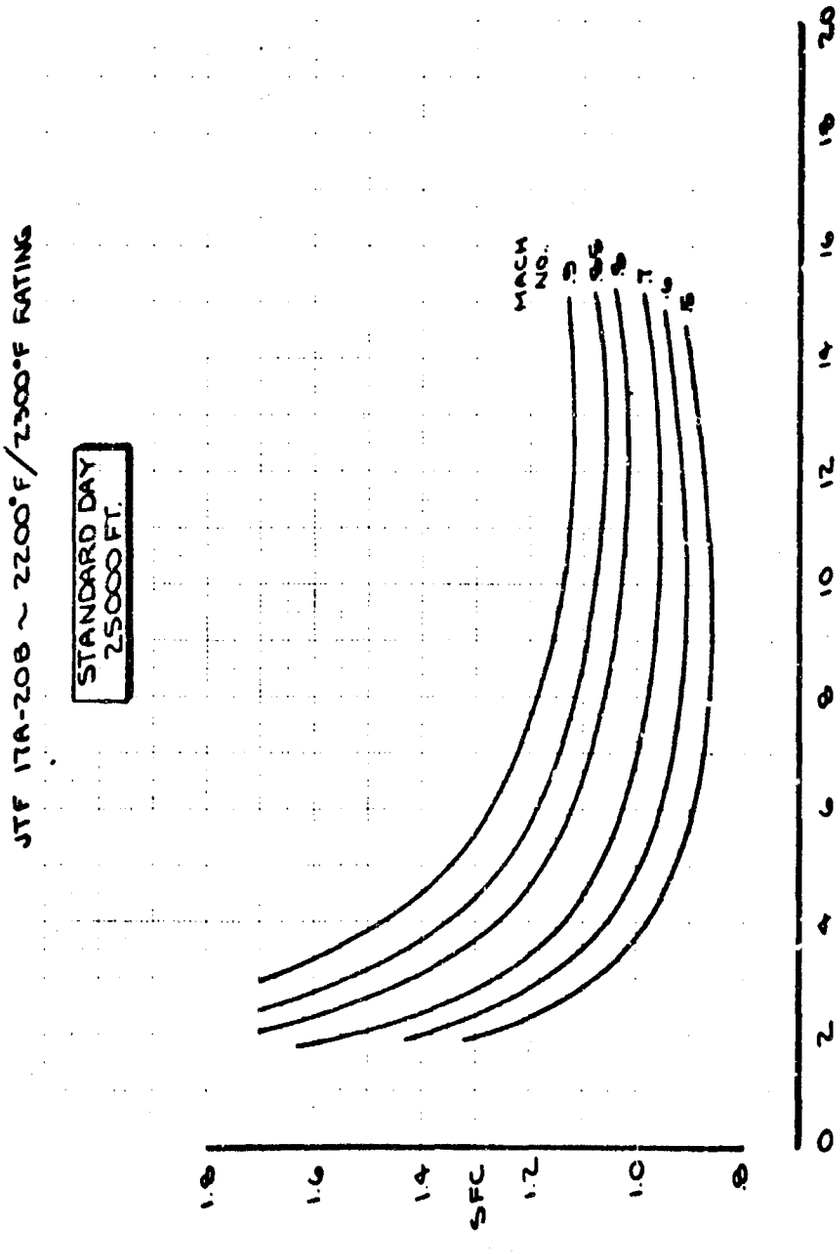

Fig. A-10 SFC versus Thrust Standard Day, 25,000 ft.

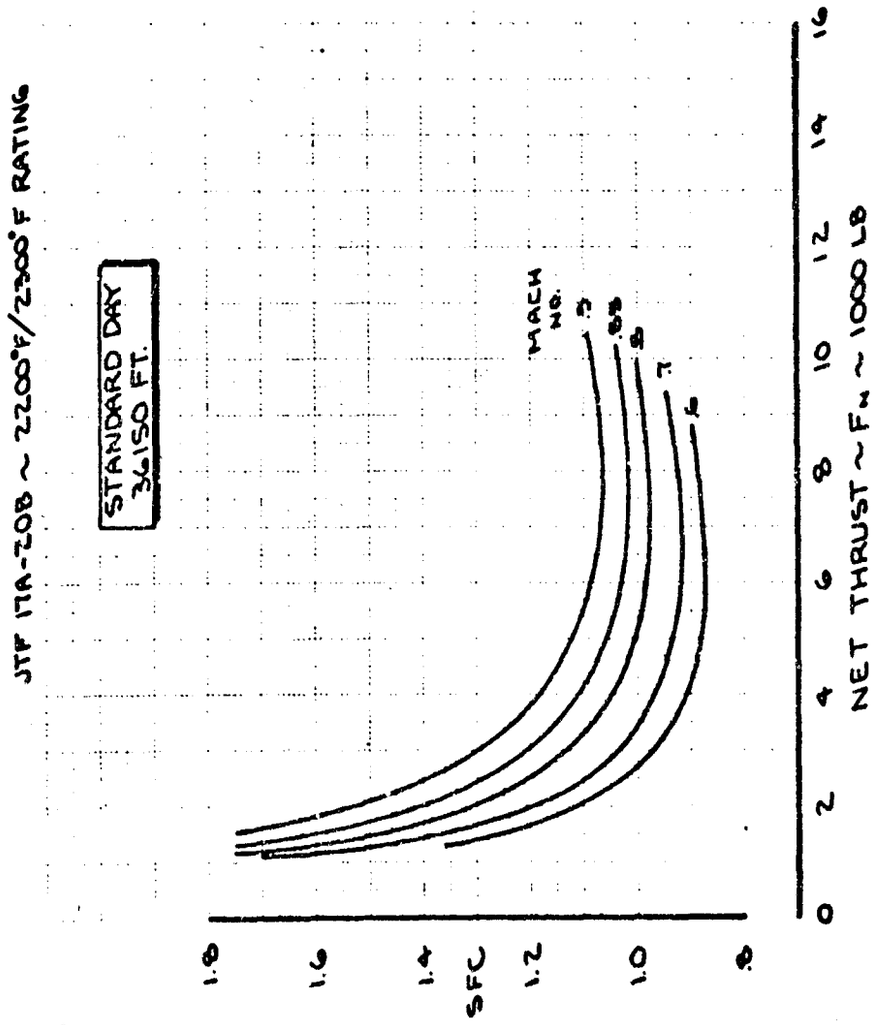

Fig. 4-11 SFC versus Thrust Standard Day, 36,150 ft.

JTF 17A-20B ~ 2200°F/2300°F RATING

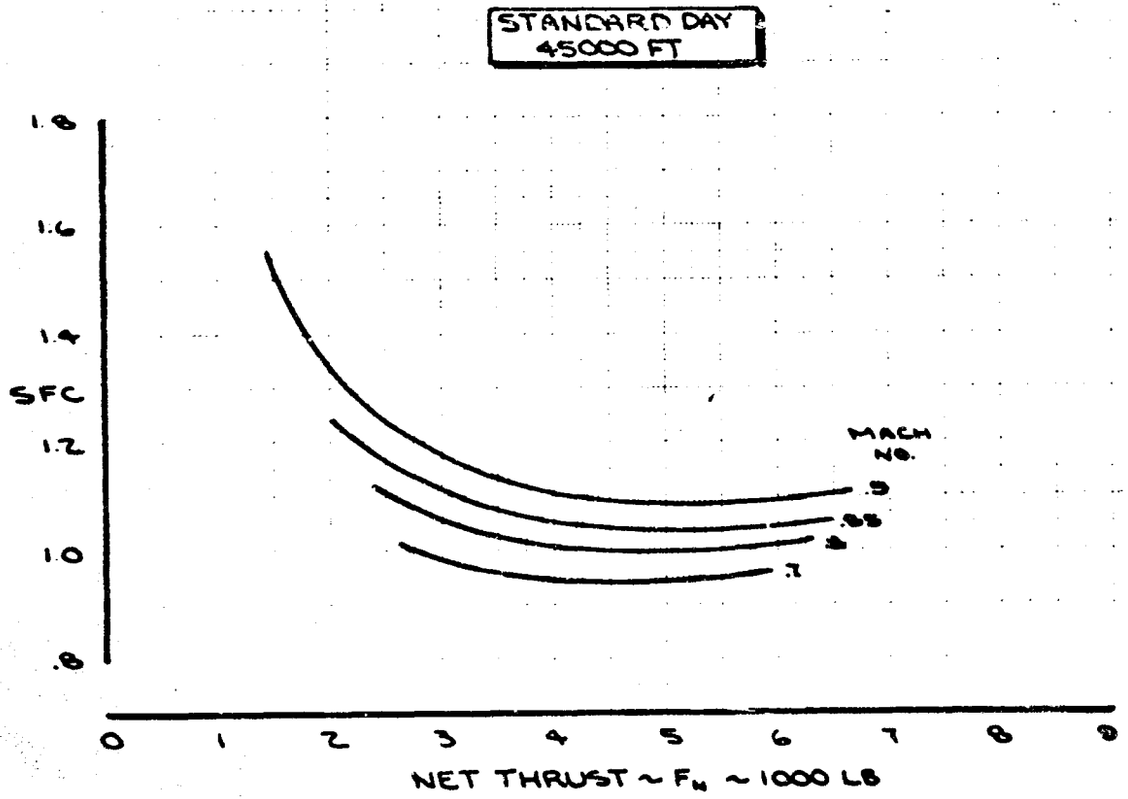

Fig. A-12 SFC versus Thrust Standard Day, 45,000 ft.